Optical spectroscopic investigation of a sol-gel process for dyeing textiles

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Textile dyeing began thousands of years ago, when plants and insects were used as sources of natural dyes for drawing and dyeing. With the development of man-made synthetic dyes, the textile dyeing industry evolved quickly and developed many successful dyeing processes. However, these processes consume large amounts of energy, chemicals and generate harmful waste water. We are currently exploring a low-temperature sol-gel process (Figure) for dyeing textiles with the aim to reduce energy and chemicals consumption. The sol-gel process is expected to form a three-dimensional silicate network encapsulating the dye and adhering to the textile fibers.[1] The sol-gel precursors can be chemically modified to incorporate further functionalities (*e.g.,* energy harvesting, luminescence).

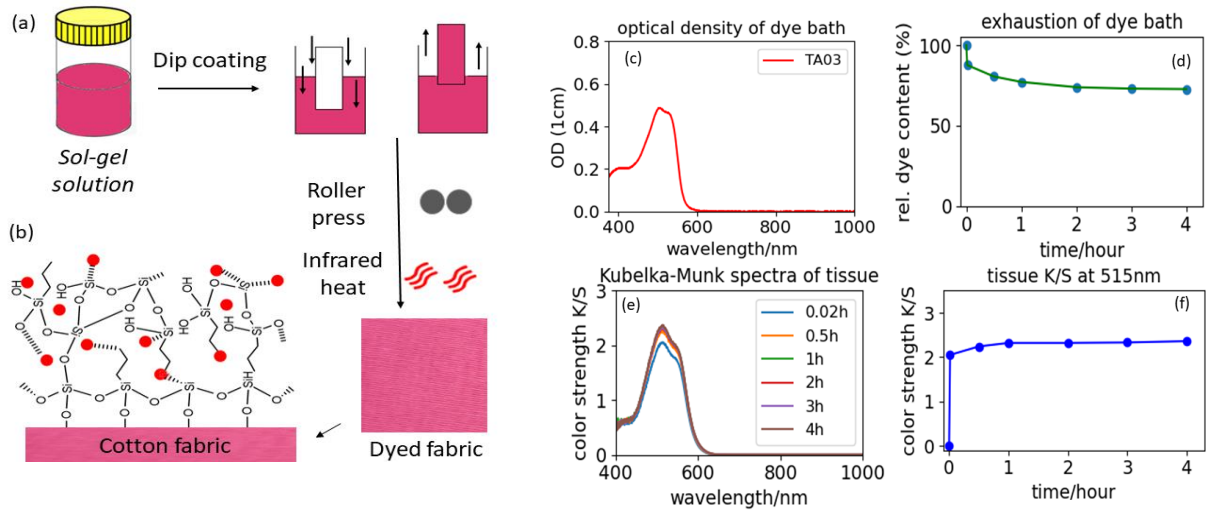

Figure. a) Sol-gel-dyeing process for cotton fabric. b) Proposed structure of the deposited dyed sol-gel layer. (c + d) absorbance spectrum of the dye in solution and dye bath monitoring. (e+f) The Kubelka-Munk spectrum of dyed textile and monitoring of textile dye content.

In our study, we monitored the evolution of the dyeing bath containing the dye and the sol-gel reactants (*e.g.*, decrease in dye content during the process) using absorbance spectroscopy (Beer-Lambert-Bouguer). We also measured the final dyed fabric using diffuse reflectance spectroscopy (Kubelka-Munk). Using these measurements, we optimized the dye process parameters and propose an optimized sol-gel dyeing process working at low temperatures (30°C) and using fewer solvents. The sol-gel process can now be modified to incorporate other materials, such as luminescent particles.

[1] A.Boukhriss, J.P. Roblin, T. Aaboub, D. Boyer, S. Gmouh, *Materials Advances* **2020**, *1*, 918-925